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TALKS WITH THE PRACTICAL OPTICIAN

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Talks With The Practical Optician

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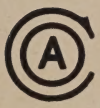

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Simple Rules for Lens Calculations

It is our aim in this article to deal with the mathematical problems that confront the surface grinder. It is our idea to give a few simple rules by means of which it shall be possible in the case of any prescription calling for sphere, cylinder, or prism, or any combination of the three, to quickly calculate *for any diameter* the thickness in the center, on the edge, or at any point at any distance from the center. In order to forestall criticism we might state that most of the rules given are simply approximate, the results being sufficiently accurate for spherical lenses up to about 10 dioptries and prisms up to about 8△. Rules for exact dimensions for any strength of lens or prism would require a working knowledge of algebra, geometry, and trigonometry, and the time required to calculate each lens would be prohibitive. These simple rules are as follows:

Rule 1. To find the thickness allowance for a lens curve or two curves combined, with no edge thickness and for a given diameter.

Multiply the half diameter of the lens in mm. by itself and point off three places, counting from right to left. Multiply the result by the dioptral number of the required lens. (For example: Find the thickness allowance for 40 mm. diameter for 4 D. The half diameter is 20 mm. and 20 x 20 is 400, and pointing off three places gives .400 or .4 mm. Multiplying by 4 gives 1.6 mm., the required thickness allowance.)

Rule 2. To find the center thickness of a finished convex lens, the edge thickness being given. Use Rule 1 and add the edge thickness. For example, find the center thickness of a lens of 60 mm. diameter + 6 diopter and 1.2 mm. edge thickness. By Rule 1, 30 x 30 = 900. Pointing off three places gives .9, and multiplying .9 by

6 gives 5.4. Adding edge thickness 1.2 to 5.4 gives 6.6 mm., the thickness in the center of the required lens. To find the center thickness of a finished concave lens, use Rule 1 and subtract the result from the given edge thickness.

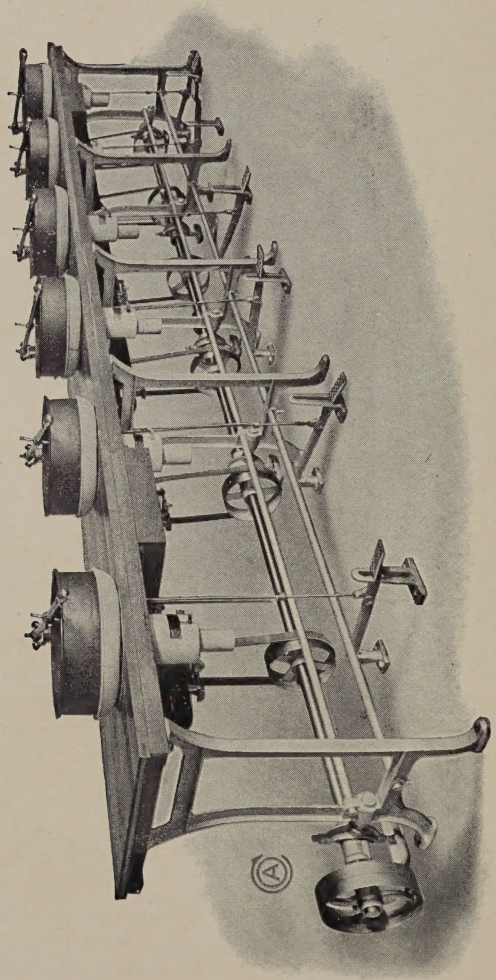
Rule 3. To find the center thickness of a finished lens, knowing the thickness at the strap or at a point a given distance from the center. Treat the distance from the center of the lens to the strap or to the given point as the half diameter of a lens, and use Rule 1. Add the result to the strap thickness if the lens is convex. If concave, subtract from the strap thickness. The result will be the center thickness required.

Rule 4. To find the edge thickness of a finished lens, having given the center thickness, dioptry, and diameter. Use Rule 1 and subtract result from center thickness for a convex lens, and add to center thickness for a concave lens.

Rule 5. To find the thickness at a point a given distance from the center, as at the strap, having given the dioptry and center thickness. Treat given distance as the half diameter, and thickness at the strap as the edge thickness and use Rule 4.

Rule 6. To find the strap thickness of an uncut lens, knowing the edge thickness. Find center thickness by Rule 2 and use Rule 5 for strap thickness.

It will be noticed that Rule 1 is the basis of all the above rules and is simply the rule for finding the center thickness of a knife edge convex or edge thickness of concave lens of no center thickness. If the lens to be figured has a cylinder surface on one or both sides, find the power of the cylinder at the given angle, using the table given below. Having found the cylinder power at the required angle from the axis, combine the result with the opposite side of the lens and treat the lens in that meridian the same as a spherical lens of the same power, using any of the given rules, as necessary.



Bench equipped with AOCo No. M21 Surface Grinders

Degrees from Axis	1 Dioptry Power	Degrees from Axis	1 Dioptry Power
0 and 180	.00	50 and 130	.587
5 and 175	.008	55 and 125	.67
10 and 170	.03	60 and 120	.75
15 and 165	.07	65 and 115	.82
20 and 160	.12	70 and 110	.88
25 and 155	.18	75 and 105	.93
30 and 150	.25	80 and 100	.97
35 and 145	.33	85 and 95	.992
40 and 140	.413	90 and 90	1.00
45 and 135	.5		

To find the power of any cylinder in any meridian. In the column marked 1 Dioptry Power find the value corresponding to the angle in column marked Degrees from Axis. Multiply this value by the dioptral power of the given cylinder, and the result will be the power of the given cylinder in the meridian required. For example: Find the power of a 6 dioptry cylinder 30 degrees from the axis. The 1 dioptry value corresponding to 30 degrees is .25, and this value multiplied by 6 gives 1.50, which is the power of a 6 dioptry cylinder 30 degrees from the axis.

Example: Prescription calls for + 2.50 sph. + 4.50 cyl. ax. 60 length of oval 40 mm. fit 1½ strap. Required center thickness. One diopter power at 60 degrees is .75 and 4.50 × .75 gives 3.37 the power of cylinder on line with strap. Combining with sphere 3.37 + 2.50 gives 5.87. The semi-diameter is 20 mm. By Rule 3 we get the center thickness, it being 3.8 mm.

The following rules are useful in making the various prism calculations:

Rule 7. To find the difference in thickness between opposite sides (base and apex) of a plano-prism, the prism dioptry and diameter in millimeters being given. Multiply the diameter in millimeters by .02 and the product by the prism dioptry required. The result will be the difference in thickness in millimeters and fractions thereof.

Rule 8. To find the difference in thickness between opposite sides (base and apex) of a sphero-prism having given the spherical power in dioptries, the decentration in centimeters (10 mm. = 1. centimeters), and diameter in millimeters. Multiply the diameter by .02, the product by the decentration, and that product by the dioptral number. The final product will be the difference in thickness in millimeters and fractions.

Note. If the prism dioptral power is given instead of decentration, change it to the latter by Rule 11.

Rule 9. To find the prism dioptry, having given the spherical dioptry and decentration in centimeters. Multiply the spherical dioptry by the decentration.

Rule 10. To find the prism dioptry, having given the difference in thickness (in millimeters) between opposite sides, and the diameter in millimeters. Divide the difference in thickness by the product of the diameter and .02.

Rule 11. To find the decentration in centimeters, having given the prism dioptry and spherical dioptry. The decentration is equal to the prism dioptry divided by the spherical dioptry.

Rule 12. To find the decentration in centimeters, having given the difference in thickness between opposite sides, the spherical dioptry, and diameter in millimeters. The decentration is equal to the difference in thickness divided by the product of the spherical dioptry, the diameter in millimeters, and .02.

Finding the Proper Spherical Curve for a Toric Lens

Unless one is constantly in touch with toric lenses, the problem of estimating the proper spherical curve to grind for a given combination is likely to be confusing. The following simple rules will be of use:

Given a *Convex Toric Surface* to find the proper *Concave* Sphere for a given combination.

For $+ \supset +$ Subtract Sphere from Base.

For $+ \supset -$ Transpose. If new sphere is Plus, subtract from Base. If Minus, add to Base.

For — ⌒ + Add Sphere to Base.
For — ⌒ — Add Sphere and Cylinder to Base.
For Plus Plain Cylinder. Concave Curve same as Base.
For Minus Plain Cylinder. Concave Curve same as Cylinder.

Examples:

CONVEX TORIC SURFACES, 6 Base

+ .75 ⌒+ 2.00. 6. less .75 gives 5.25 for the Concave Curve.
+ 1.00 ⌒ — 1.50. Transpose to — .50 ⌒ + 1.50. 6. added to .50 gives 6.50 required Curve.
+ 2.50 ⌒ — 1.50. Transpose to + 1.00 ⌒ + 1.50. 6. less 1.00 gives 5.00, the required Curve.
— 1.00 ⌒ — 2.50. 1.00 + 2.50 + 6.00 ⌒ 9.50, the required Curve.

Given a *Concave Toric Surface* to find the proper *Convex* Sphere for a given combination.

For + ⌒ + Add Sphere and Cylinder to Base.
For + ⌒ — Add Sphere to Base.
For — ⌒ + Transpose. If new Sphere is Plus, add to Base. If Minus, subtract from Base.
For — ⌒ — Subtract Sphere from Base.
For Plus Plain Cylinder. Convex Curve same as Cylinder.
For Minus Plain Cylinder. Convex Curve same as Base.

Examples:

CONCAVE TORIC SURFACES, 6 Base

+ 1.25 ⌒ + 1.75. 1.25 + 1.75 + 6. gives 9.00, required Curve for the Convex Surface.
+ 1.25 ⌒ — 2.00. 1.25 added to 6. gives 7.25, the Curve for the Convex Surface.
— .50 ⌒ + 2.00. Transpose to + 1.50 ⌒ — 2.00. 1.50 + 6. gives 7.50 for the Convex Curve.
— 2.00 ⌒ + .50. Transpose to — 1.50 ⌒ — .50. 6. less 1.50 gives 4.50 for the Convex Curve.
— 2.00 ⌒ — 3.00. 6. less 2.00 gives 4.00 for the Convex Curve.

To Grind AOCo n. 1.507 with Tools Turned to the Higher Index

As every surface grinder knows, there are two series of grinding tools now in general use in prescription shops; the one turned to grind AOCo n. 1.507 glass, and the other turned to the higher index. As a general rule, the surface grinder prefers to employ but one set of tools, either the higher or lower index, rather than submit to the inconvenience of changing back and forth from one to the other as he handles the two kinds of glass.

It is a simple matter for the grinder whose tools are turned to the higher index to grind AOCo n. 1.507 glass by making the necessary allowance, briefly given in the following table:

Table for Grinding AOCo n. 1.507 Glass with Higher Index Grinding Tools

POWER WANTED	TOOL TO USE		REMARKS
0.12 to 1.37	same	from	.75 to 1.37 polish strong
1.50 to 4.12	.12 stronger	from	1.50 to 2.00 polish weak 3.62 to 4.12 polish strong
4.25 to 6.75	.25 stronger	from	4.25 to 4.75 polish weak 6.25 to 6.75 polish strong
6.87 to 9.50	.37 stronger	from	6.87 to 7.37 polish weak 8.87 to 9.50 polish strong
9.62 to 12.00	.50 stronger	from	9.62 to 10.25 polish weak

EXAMPLE: If a 1.75 power is wanted, use a 1.87 tool and polish weak.

For Cement Bifocals, regular AOCo wafers can be used.

To Grind Kryptoks with Tools Turned to AOCo n. 1.507 Glass

The surface grinder who has an equipment of grinding tools the surfaces of which are turned for use on AOCo Glass of n. 1.507 will be glad to obtain authentic information for guidance in using these tools on Kryptoks to obtain the proper dioptral powers. The following rules apply when AOCo n. 1.507 tools are used for both surfaces.

Kryptok Flat Blanks. No allowance need be made on account of the difference in index, for distance powers up to 2 D, as the average error will amount to only .03 D, which may be disregarded. Should it happen that the distance focus is ordered stronger than 2 D, it is merely necessary to grind one surface with a tool .12 D weaker than the power required.

Kryptok Toric and Meniscus Blanks (6 D Base). Grind one side with a tool .12 D weaker than the power called for. The toric or meniscus (6 D Base) form of lens tends to increase the power .06 D to .08 D and the difference in index between the glass and the curve of the tool increases it in addition by .03 D to .04 D. Therefore the allowance of .12 D produces the correct focal power.

Caution. In following the foregoing rule do not polish strong. Use a small felt disk and throw the lens well out over the side to polish the center of the lens. After polishing half a minute, examine the lens surface. If the outer edge of the lens is polished more than its center, reduce the diameter of the felt disk until the entire surface of the lens polishes evenly. On a weak curve the diameter of the polishing felt may be as large as the tool, whereas on a strong curve it should be but a little larger than the lens. This also applies to the polishing of toric or cylindrical surfaces, in which case it may be necessary to make the diameter of the polishing felt considerably less in the cylinder meridian than on the axis.

Suggestions for Surfacing Onepiece Bifocal Ophthalmic Lens Blanks

Onepiece Patented Bifocal Lenses will neutralize correctly when surfaced on the convex side with +6.D. base tools of index 1.53, which must be accurate to gauge. To use any other base, add or subtract the difference from curves in column marked "Distance Power."

Laying Out: Dot around the dividing line with red or white marking ink and lay the blank on protractor. Locate and dot the required position of the optical centre of distance portion and axis of cylinder, if any, at the same time "insetting" the reading portion the required amount for convergence. We recommend an allowance of 1½ mm. above the dividing line for the distance centre, and our blanks are cut to allow for that. Special protractors will be furnished upon application for laying out these blanks for surfacing and edging.

Locate measuring points equidistant from centre as marked on protractor. When marked in this manner, crumbing before surfacing is unnecessary. If prism is required, lay out line for direction of prism and measure thickness on this line.

Blocking: Use AOCo Iron blanks 47 (mm.) diameter: 4D., 6D. or 8D. convex surface as necessary and AOCo M312 pitch. Pitch should be of uniform thickness, not less than 3 mm. between lens and block. Heat the blank slowly and evenly, avoiding overheating.

Grinding: Rough the blank to thickness required, using AOCo No. M301 roughing emery, and allow 0.2 mm. for smoothing, measuring thickness at the marks frequently to avoid grinding prismatic. If opposite points measure alike, optical centre will be in correct position. Do not measure on the reading portion, as the lens is thicker there. It is absolutely necessary to use smoothing emery, AOCo No. M302, for second grinding before using the finishing emery. Finishing emery, AOCo M303, is for finishing only, and is not intended to remove stock.

Correct results can only be obtained when these directions are literally followed. Great care should be taken with both the smoothing and the finishing opera-

tions to ensure exact focal values, and a high lustre when surface is polished.

Polishing: Use thin polishing felt of best quality, AOCo M306, and AOCo M308 wet-ground polishing compound (rouge).

As Onepiece Patented Bifocal Lenses are made from one piece of glass, all strains due to uneven expansion are eliminated, and possibility of breakage is reduced to a minimum. The lenses can be ground extremely thin even when addition is strong, and show entire freedom from color.

Blanks are exchangeable only for manufacturing defects. They must be returned in original cartons.

Use Onepiece Blanks Made By AOCo.

Kryptok Suggestions

Selecting the required Kryptok Blank. First decide on the form of the finished lens, whether Toric or Flat. Next determine the required curve on the Disc side. Find this curve in the Vertical Column marked "Curve on Disc Side," using the Toric or Flat chart as necessary. Next find the reading addition in the Upper Horizontal Column marked "Addition Required."

Where these two columns cross each other will be found the number of Blank required. This can be readily understood by verifying the following examples all of which have +1.00 Distance with +1.50 Reading Addition. (Note. The Reading Addition in all cases is understood to mean the Power actually *added* for reading and not the total power of the reading portion.)

If in Dcx form (Disc side curve +.50) use Blank No. 30.

If in Pcx form (Disc side curve +2.25) use Blank No. 23.

If Meniscus Cx form (6.00 Base) (Disc side curve +7.00) use Blank No. 329.

If Meniscus Cx form (9.00 Base) (Disc side curve +10.) use Blank No. 817.

If Plano Cyl. form (Disc side Plano) use Blank No. 32.

Caution. Never Grind a Cylinder on the Disc Side.

Blocking a Kryptok. Select a block adapted to the lens to be ground. If the lens surface next to the block is flat or nearly so, the block should be flat. If the lens surface is curved, the block should be curved. Briefly stated:

The layer of pitch between the lens and block should be of uniform thickness at all points and never less than ⅛ in. thick. This applies particularly to the final blocking of the lens for grinding the second surface and if heeded *will avoid* a lot of *breakage*.

Heat the blank *gently* and avoid *sudden changes in temperature*. After blocking allow the blank to cool thoroughly before commencing to grind.

Grinding a Kryptok. Always grind the disc side first, using rough emery (M301) simply to remove surplus glass. With smoothing emery (M302) reduce the diameter of the disc to within 2 mm. of its finished size if a high addition, or 4 mm. if a low addition. With finishing emery (M303) reduce the disc to its final diameter. Great care should be taken to obtain the best possible finish with the fine emery, otherwise too much is left to the polishing, and the disc will not only show a wavy surface but will tend to polish flat, thus changing the reading focus.

In finishing the lens with M303, run the emery down until it is worn out or dead, being careful not to carry the process too far, which would allow the lens to rub on the iron and scratch the surface.

Before surfacing the second side locate and dot the required optical centre of the distance portion, and crumb the blank until the optical centre is equally distant from opposite edges of both the long and short diameter. Then grind the opposite edges to equal thickness for each respective diameter. This will locate the optical centre of the distance portion at the point desired.

We recommend a distance of 1½ mm. from the upper edge of the reading portion to the optical centre of the distance portion.

Polishing a Kryptok Lens. Use piano felt, printers blanket or closely woven serge cloth. For polishing material we recommend our M308 rouge, which is put up wet ground in five-pound cans. When polishing very weak additions, it will be found that the disc will reduce slightly in diameter.

Avoid excessive pressure. On the disc side it tends to polish the disc flat. On the second side it is liable to break the lens.

Picking off a Kryptok Lens. The lens may be chilled in cold water but must be *cooled slowly as sudden changes*

of temperature will crack a Kryptok, owning to the difference in the expansion of the crown and flint. After cooling, to remove the lens, tap it carefully around the edges with a piece of hard wood. After removing it from the block, clean with turpentine.

Table of Minimum Thickness. (Diam. of Disc 19 mm.) The following table shows the *Minimum thickness* of a finished Kryptok measured at the centre of the disc. If ground thinner than the figures given, the flint disc will be exposed on the second side and the lens destroyed.

Addition	*Min. Thickness*
.50	.3 mm. or 1½ points
1.00	.6 " " 3 "
1.50	.9 " " 4½ "
1.75	1. " " 5 "
2.00	1.1 " " 5½ "
2.25	1.3 " " 6½ "
2.50	1.4 " " 7 "
2.75	1.6 " " 8 "
3.00	1.7 " " 8½ "
3.25	1.9 " " 9½ "
3.50	2. " " 10 "
3.75	2.1 " " 10½ "
4.00	2.2 " " 11 "

(Note. The points referred to in above table are the ⅕ mm. graduations on the M197 Spring millimeter gauges in common use.)

Cutting a Kryptok Lens. Carefully locate and dot the optical centre of both distance and reading portions, also the axis of cylinder, if any. Place the lens on an oval diagram, and after properly locating the axis and optical centres as required, trace the oval on the lens with a pen and ink. Cut to the oval with a *good diamond. A poor diamond will break good Kryptoks.* We can supply diamonds and cutting machines especially adapted for Kryptok work.

Mounting a Kryptok Lens. When drilling, use a *sharp* diamond drill and *light pressure.* If your drilling outfit is not in proper condition, *call on us.* Do not cramp or strain the lens in mounting. *Broken Kryptoks are expensive.* The Colmascope will show up any strain sufficient to break a lens.

Fitting a Kryptok Lens. To avoid colors. Use the Toric form of lens and tilt slightly if necessary, in order that the wearer shall look squarely through the reading portion. The astigmatic effect of oblique vision through a lens is much greater than is generally supposed and is much more pronounced through the reading than through the distance portion.

Convergence requires that the reading portion should be "Decentered in" a certain amount in order that the wearer shall look through the *optical centre* when reading.

For pupilary distances ranging from 2⅛" to 2½" the following figures are sufficiently accurate:

For 10" reading distance, Decentre in 1¾ mm.

For 12" reading distance, Decentre in 1½ mm.

For 14" reading distance, Decentre in 1 mm.

By attention to the precautions noted, the loss by breakage and other causes will be reduced to a minimum and profits on Kryptoks correspondingly increased.

Suitable Abrasives and the Proper Method of Using Them

For the surfacing of spectacle lenses we have developed three grades of emery, which, when used in accordance with the suggestions that follow, produce a superior fined-out surface and may easily reduce the time usually required for polishing almost one-half.

These three grades are: AOCo No. M 301 emery for roughing; AOCo No. M 302 emery for smoothing; AOCo No. M 303 emery for finishing. *We do not guarantee our No. M 303 finishing emery unless its use is preceded by the AOCo M 302 smoothing emery.* Put up in five-pound containers.

AOCo No. M 301 Roughing Emery. This emery is especially refined and graded for spectacle lens surfacing. It is particularly adapted to this work, its quality and fineness being the result of years of research and experiment. It should not be confused with the ordinary commercial emeries intended to be used for other purposes which invariably contain objectionable foreign matter, rendering them unfit for lens grinding.

To properly use this material, mix it with water to the consistency of a thick paste and apply to the lap, using a

AOCo Abrasives

small scoop or spoon. Rough away the glass to within 0.2 mm. of the finished thickness, allowing not less than this amount for the smoothing operation.

AOCo No. M 302 Smoothing Emery. Wash the roughed-out lens blank very carefully to remove every particle of AOCo M 301 roughing emery. With a brush apply AOCo No. M 302 smoothing emery mixed with water to form a paste. Grind very close to the finished thickness, allowing less than 0.1 mm. of stock for the finishing emery. Toward the end of the smoothing process, work the emery down, applying water drop by drop as necessary, until the emery assumes a dark brown color. Again wash carefully in clear water. Be sure that a uniform surface is obtained with AOCo No. M 302 smoothing emery before the AOCo No. M 303 finishing emery is used.

AOCo No. M 303 Finishing Emery. This is essentially a finishing emery and is not intended to remove stock. It is prepared in a dry state. Mix to a paste with water and apply with a small brush to the centre of the tool, allowing it to work out towards the edge while running. Use a *light pressure*, always keeping a fine film of emery between the lens and grinding tool. The surface should never be

allowed to run dry, and when properly finished should present a dark blue appearance. A lens properly smoothed with AOCo No. M 302 smoothing emery may be irreparably scratched from failure to observe these simple precautions.

This scratching *is not due to grit in the emery*, but, on the contrary, is due to the emery running dry or to excessive pressure, causing the tool to come into direct contact with the glass and tearing deep grooves in the surface.

AOCo emery in all grades is furnished in a perfectly dry state. This is necessary to ensure its being received in perfect condition. There is, therefore, no possibility of the formation and scaling of rust from the inside of cans, which would render it unfit for use.

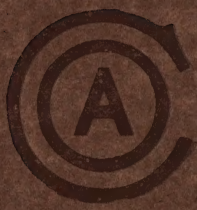
Note. We furnish, when desired, a special grade of finishing emery slightly coarser than M 303 and which we list as M 302½.

AOCo Polishing Compound. This material is a special compound of rouge for polishing lens surfaces after finishing with AOCo No. M 303 finishing emery. It will be found to be the most satisfactory preparation that can be secured for this purpose. It is supplied in two forms, as follows: AOCo No. M 308 Polishing Compound, wet-ground ready for use; AOCo No. M 309 polishing compound, dry-ground. *We recommend and use in our own works No. M 308 wet-ground polishing compound.*

AOCo No. M 308 Polishing Compound. Before using, see that every particle of emery has been washed from the lens and iron block. Do not use the same pan that you use for grinding. AOCo surface machines are supplied with extra pans for polishing. Apply polishing compound to the felt-covered tool with stiff brush, and finish on high speed. As stated above, the time required for polishing may be greatly reduced if the lens has been properly ground. *It is absolutely impossible to obtain a brilliant polish on a lens surface unless the above directions are faithfully carried out.*

AOCo No. M 309 Polishing Compound. This material, being furnished dry, must be mixed with water for use. A little practice will show the proper consistency. After being properly mixed it is applied the same as AOCo No. M 308 polishing compound mentioned above. Both forms put up in five-pound containers.

TALKS WITH THE PRACTICAL OPTICIAN



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